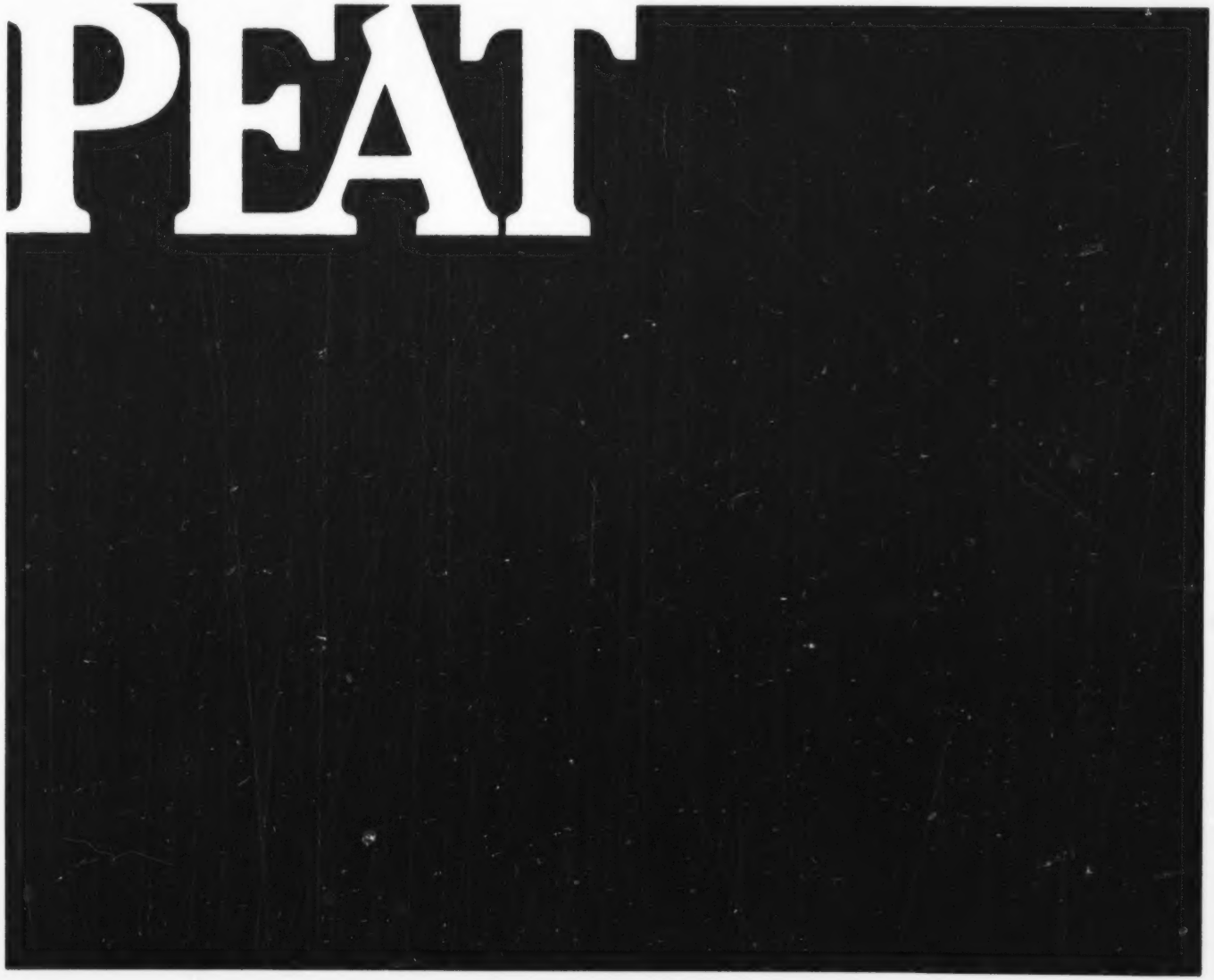
PEAT IN ONTARIO
A New Awakening for an Old Fuel

Ontario
Ministry
of
Energy

PEAT



INDEX

5 MINISTER'S FOREWORD

6 PEAT: IN GENERAL

8 SYMPOSIUM ON PEAT:
AN AWAKENING NATURAL RESOURCE

8 PEAT: NON-ENERGY USES

9 FUEL PEAT

10 BOG SELECTION AND PREPARATION

11 PEAT MINING METHODS

12 PROCESSING METHODS

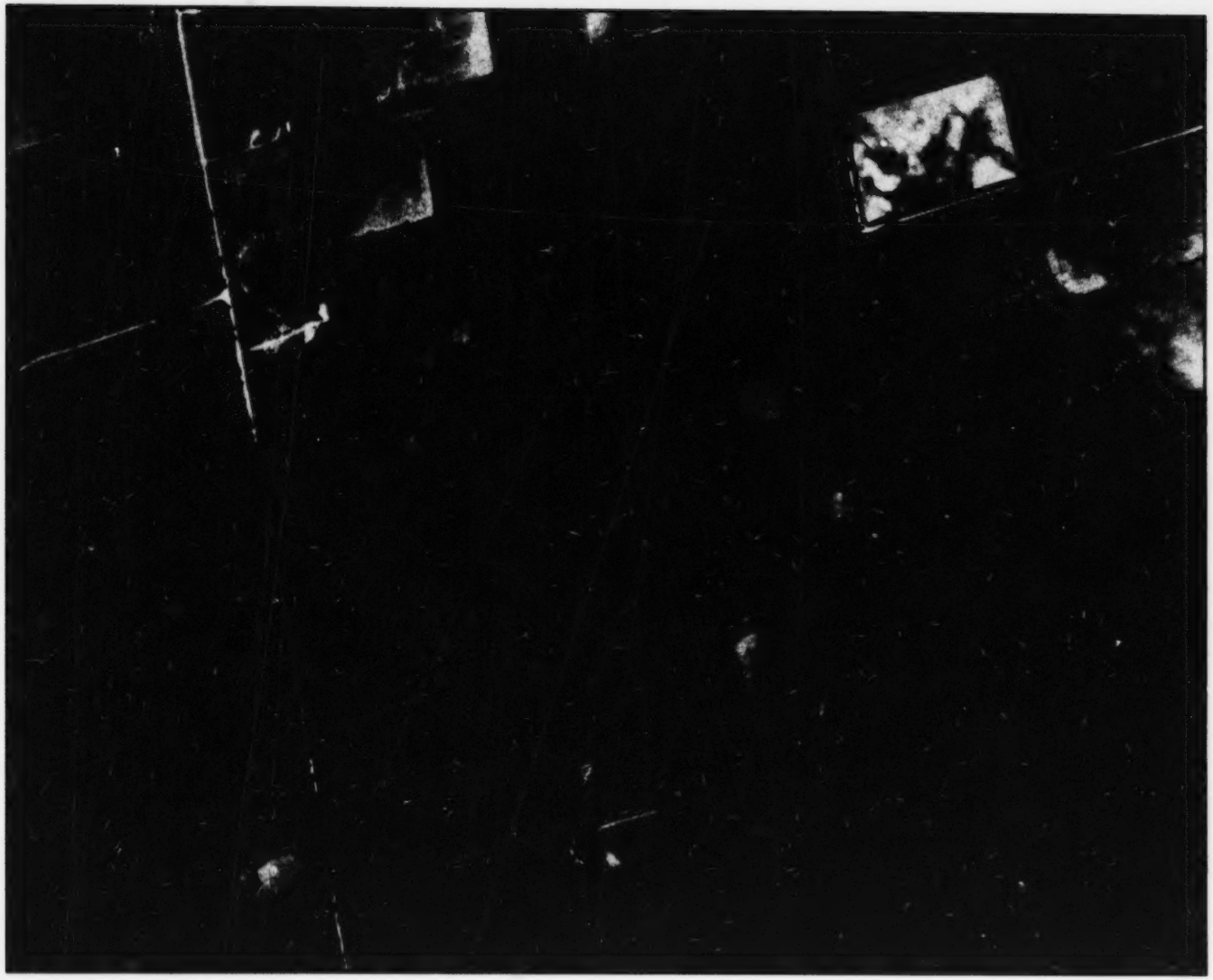
14 POTENTIAL ENERGY USES

16 REGULATORY AND ENVIRONMENTAL
GUIDELINES

17 POTENTIAL INVESTMENT CAPITAL

17 CONCLUSION

18 APPENDIX I



Peatland in Southern Ontario near Lake Simcoe

MINISTER'S FOREWORD

The U.S.S.R., Ireland and Finland have used peat as a heating fuel for centuries. They even use it to fuel some of their electric power generating stations. However, Ontario and the rest of Canada had access, until recently, to an abundance of relatively cheap and convenient energy resources – primarily oil.

As oil costs continue to increase and security of supply becomes more of a concern, we must turn to our own indigenous resources of alternative energy supplies to reduce our dependence on expensive petroleum-based fuels.

Peat is just one of the energy alternatives at which Ontario is looking. But it is an important one – one which will have a key role to play in making both Ontario and Canada energy self-sufficient.

As Canada's major energy consuming province, we must play a large role in helping Canada become an energy self-sufficient country. To do this, Ontario has set several goals. One of them is that by 1995 we will be producing 37.5% of our primary energy from indigenous sources.

To obtain a better understanding of the development potential of peat in Ontario, a comprehensive study was conducted by Monenco Ontario Limited for the Ministries of Energy, Natural Resources, and Northern Affairs.

The Monenco study, which will be covered in more detail elsewhere in this report, indicates there are nearly 10 million hectares of peatland south of the permafrost limit in Ontario – an energy resource we in Ontario have never tapped. This peat has the energy equivalent of approximately 26 billion barrels of oil.

It comes as no surprise, then, that the Monenco study concluded there is definitely enough peat in Ontario to make it worthwhile developing.

As with any "new" energy development – and even though peat has been used as a fuel for centuries, it is "new" to Ontario – progress is based on knowledge.

It is hoped that this booklet will help supply some of that needed knowledge: knowledge of potential uses, the extent of the retrievable resources, their accessibility, and development methods.

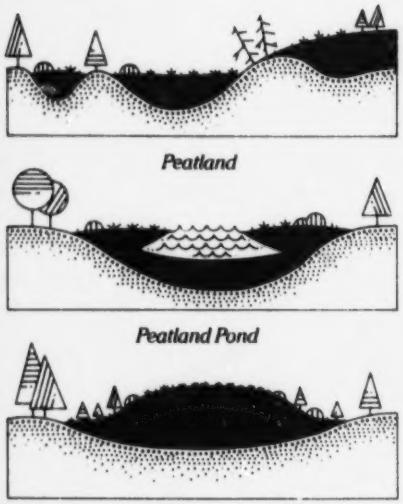
Robert Welch

Honourable Robert Welch, Q.C.

Sphagnum Moss

PEAT: IN GENERAL

Types of Peatland



Peatland

Peatland Pond

Raised Peat Bog

Peat is found in wetlands, often called bogs, swamps, or fens. The water there is generally stagnant, has formed a small lake or beaver pond, and has accumulated either from rain or flooding streams. The peat has gradually formed since the ice age, created by the progressive accumulation, submergence and incomplete decomposition of plant life in this water-saturated environment.

Peat occurs in two forms which differ in both their chemical and physical structures, as a result of a process known as humification.

As humification progresses, the colour of peat changes from yellowish-brown to near-black, the fibrous content diminishes and the material becomes mud-like as its bulk density increases and its water absorbing capacity diminishes. Chemically, it becomes like a young coal. The peats best suited for non-energy uses are sphagnum peats of a low degree of humification. Energy peats are sphagnum or sedge peats with a high degree of humification.

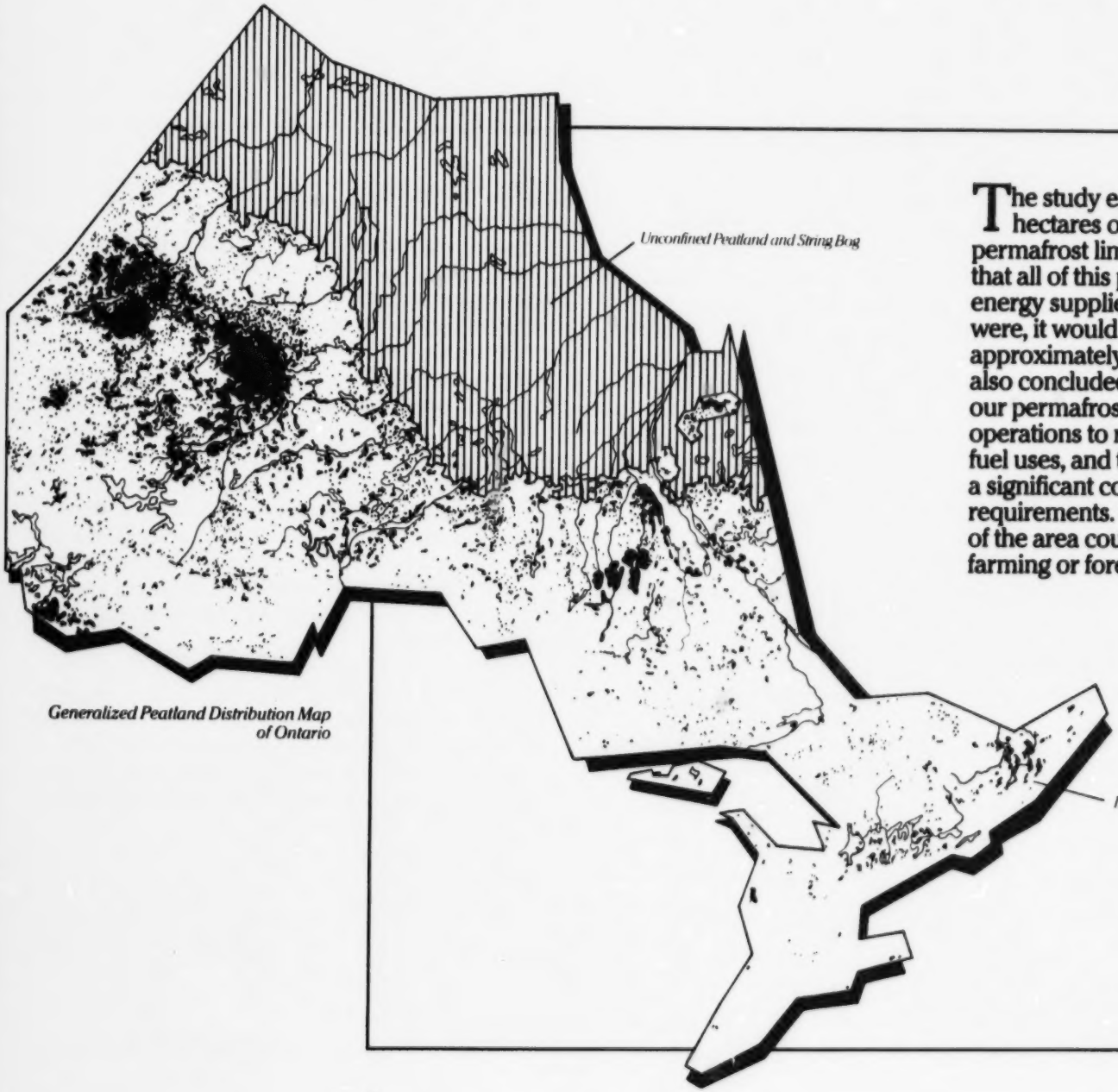
Horticultural peat (peat moss) is yellowish-brown and used primarily in agriculture and gardening for soil enrichment. It consists of humic material, plant fibres, inorganic sediment and, in its natural state, about 90% water.

Fuel peat is usually found beneath the horticultural peat in the wetlands of boreal forests and tundra. Although concealed, its presence is indicated by the characteristic tea-coloured water, sedges, grasses and stunted spruce trees. But only a thorough investigation can determine the extent of the fuel peat located in each bog.

Ontario's Ministries of Energy, Natural Resources and Northern Affairs are encouraging the development of peat. Aside from its energy potential, peat production could also become an important job-creating industry. This interest led to a study of the extent and usefulness of the peat in this province. The report, Evaluation of the Potential of Peat in Ontario: Energy and Non-Energy Uses, was presented at the Symposium on Peat in October 1981 at Thunder Bay.*

Written by peat specialists and economic analysts at Monenco Ontario Limited, in collaboration with the Ontario Research Foundation, the study concludes that Ontario has substantial peat resources.

*The complete study, EVALUATION OF THE POTENTIAL OF PEAT IN ONTARIO, by Monenco Ontario Limited, has been published by the Ministries of Natural Resources, Northern Affairs and Energy and is available from the Ontario Government Bookstore for $20.00.

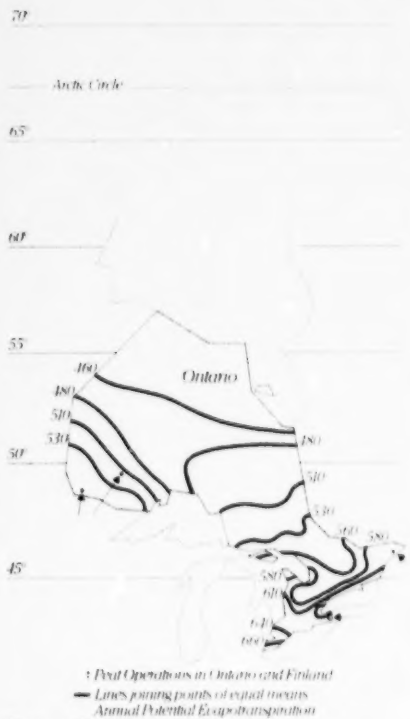


Generalized Peatland Distribution Map of Ontario

The study estimates that about 9.9 million hectares of peatland occur south of the permafrost limit in Ontario. While it is unlikely that all of this peat will ever be developed for energy supplies, it is interesting to note that if it were, it would yield the energy equivalent of approximately 26 billion barrels of oil. The study also concluded that there is enough peat south of our permafrost line to warrant full-scale mining operations to recover it for both horticultural and fuel uses, and that peat could eventually provide a significant contribution to our total energy requirements. Once the bogs were mined, most of the area could be reclaimed and used for farming or forestry.

SYMPOSIUM ON PEAT: AN AWAKENING NATURAL RESOURCE

A provincial initiative to foster peat development



Geographic and climatic similarities of Northern Ontario and Finland. See page 9 for map of Finland.

The Ministries of Energy, Natural Resources, and Northern Affairs, in conjunction with the Canadian National Committee of the International Peat Society, sponsored a symposium on peat at Thunder Bay in October 1981.*

It attracted scientists, researchers, consultants, peat operators and potential peat product users, entrepreneurs interested in peat development opportunities, and significant media attention. Over 240 delegates attended the two-day symposium with representation from across Canada, the United States and Europe. The response of these delegates – from both the public and the private sector – demonstrated that there is no shortage of interest in peat development in Ontario.

Leading authorities shared their experiences and knowledge on such subjects as peat resources and utilization, peat inventory, mining and dewatering techniques, and research and development initiatives. Their presentations illustrated that while peat may be "an awakening resource" in Ontario and other Canadian provinces, considerable experience and expertise exists in other parts of the world.

*The Proceedings of the Symposium on Peat are available for $20.00 from Mr. T. E. Tibbetts, The Canadian National Committee of the International Peat Society, c/o National Research Council of Canada, Atlantic Research Laboratory, 1411 Oxford Street, Halifax, Nova Scotia, B3H 3Z1

PEAT: NON-ENERGY USES

Ontario is interested in both fuel and horticultural peat. Since both are usually found together, it is only natural that the horticultural peat – which must be removed before the fuel peat can be reached – should also be developed. As a soil additive, horticultural peat increases humus content, enhances the soil's ability to hold moisture, and also improves aeration. It can be used as a growing medium in greenhouses, and as a starting medium for household gardeners.

Canadian sphagnum peat is well-recognized as a superior grade horticultural peat with a high water retention factor. A horticultural peat mine could be developed to produce bagged sphagnum peat moss in Ontario for domestic and export markets.

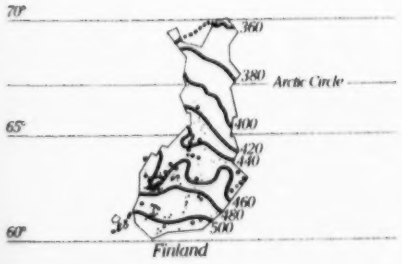
Because peat is so porous, it is also used for pollution control. For example, industrial waste water leaves its solid particles and dissolved heavy metals behind in the peat as it passes through. Peat moss has been used to control oil spills – an 82 kilogram bale is capable of absorbing about 500 litres of oil.

FUEL PEAT

Since Canada has never mined fuel peat, it was necessary to look for advice to those countries which have.

Finland was taken as the primary model for several reasons. First, the climate of northwestern and central Ontario was found to be very similar to that of Finland for the May to September peat mining period. The Finnish systems and mining methods also seemed most suited to Ontario conditions. They use the conventional peat mining methods such as milled and/or sod peat systems. Wet mining is also used to a limited extent, primarily for horticultural sphagnum peat production.

Ontario is studying direct combustion technologies, where the peat is burned with minimum processing, as well as gasification – using peat to produce liquid fuels such as methanol and substitute natural gas (SNG). Although gasification has yet to be demonstrated on a commercial scale, it appears to have potential.



Finnish Sod Peat Equipment

BOG SELECTION AND PREPARATION

Peatlands are a natural resource with potential for a variety of uses. For proper planning, this resource should be surveyed to determine the type of peat, its quality and the size of the deposit. In addition, other factors such as potential markets for the peat products, and the economics of developing the resources should be considered.

This section deals with bog selection and preparation after the peat deposits are located with the help of aerial photographs and satellite imagery.

To determine if a peat bog has sufficient peat to be developed, core samples must first be taken. At all points, elevations are measured and the following information recorded:

- bog and sample site identification
- site elevations
- number of stumps and wood remnants in upper 2 metres
- the type of peat (moss) and changes with depth
- the humification level of the peat
- its wetness on a scale of 0-5 (3 being normal)
- the type of fibre in the peat
- additional pertinent remarks
- wildlife

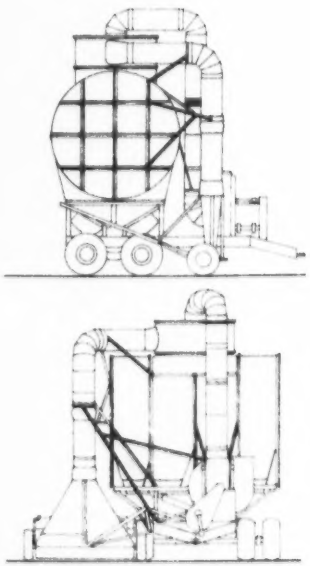
Once a bog has been selected for development, the water must be drained. Trenches are dug, but it may be several years before the drainage is complete enough for the peatland to be able to support the heavy equipment necessary for the subsequent steps. At that time, living plants, stumps and small trees are removed.

The machinery necessary for all the mining procedures discussed in this section (e.g. self-powered tractors) is generally manufactured in Ontario and, with minor modifications, could be well suited for peat operations. When Canadian-built machinery is not available, Finnish peat production machinery could be manufactured here under licence from the parent company.

Once any horticultural peat is removed, fuel peat can be mined or harvested by two conventional methods: milled or sod.

Bog Ditching Machine

PEAT MINING METHODS



Canadian Milled Peat Vacuum

MILLED PEAT MINING–The top layer of fuel peat is sliced into one thin layer (usually an inch thick) at a time. Once this loosened surface layer is air-dried to 45% moisture, it is scraped off and collected. Either of two collection methods, vacuum or ridged peat, each using different types of machinery, can be used:

VACUUM METHOD–The air-dried peat is gathered by a vacuum collector. A milling device which pulverizes the peat is usually towed behind the unit to prepare the next surface layer. The peat then passes a storage tank on the vacuum collector, and is finally dumped into a storage pile at the end of the field. From there, the peat is transported to the final storage area for end use.

RIDGED METHOD–The milled peat is ploughed into ridges in the centre of the field. After further drying, the ridges are transported to either a bogside storage facility, or directly to a thermal power plant or other industrial user.

SOD PEAT MINING–The sod peat production method is based on air-dried lumps of peat which have been cut from the bog. Specialized equipment cuts vertically into the surface of the peat and extrudes it into either bricks or rolls of solid peat. These are left stacked on the surface of the bog to dry.

This method is used in Finland, only when milled peat methods are not technically feasible. It is more expensive than milled peat mining.

WET PEAT MINING–The wet mining of peat refers to the method whereby peat is removed from its original site directly to the user or artificial drying equipment without any air-drying on site. There are two major advantages to this method:

1) Peatland areas can be utilized where bog drainage is impossible,
2) The harvesting season can run eight months, instead of the three months available for air-dried mining.

The costs of wet mining can be much lower than other methods, but only if low-cost energy supplies are available to economically dry the peat to 50 per cent moisture content.

The major obstacle is that the mechanical dewatering operation is presently technically unproven for use in commercial scale operations.

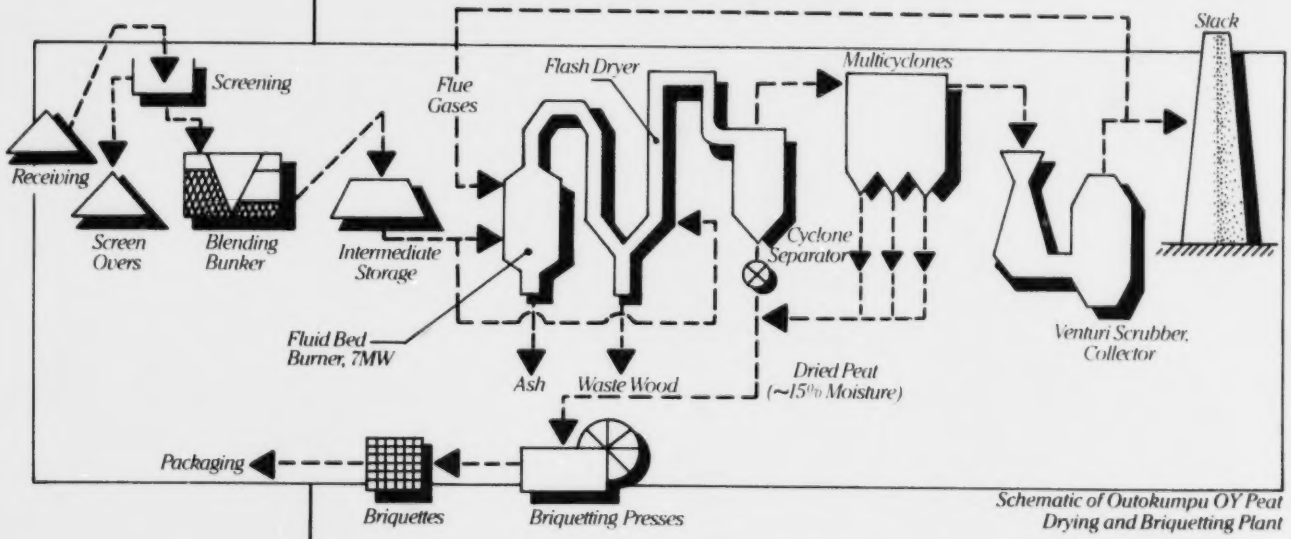
PROCESSING METHODS

Peat, as found naturally, may contain over 90 per cent water. Depending upon its eventual use, the water content of the peat must be reduced to at least 50 per cent. Most of the peat in use today is air-dried to 30 to 50 per cent in the course of mining.

Although researchers are working to develop better dewatering methods, more progress must be made before some of the hoped-for applications of peat are economically feasible.

The wet mining method, for example, would be the most attractive method of recovering peat for energy purposes if dewatering processes were more economical.

The current methods used to dewater wet mined peat include roller presses for horticultural peat and belt presses for fuel peat. Each can lower moisture content to 70 per cent. Thermal dryers will further reduce the moisture content to 50 per cent or lower. For larger scale production, a wet carbonization process yields a uniform, pelletized or powdered solid fuel at 8 per cent moisture.



Schematic of Outokumpu OY Peat Drying and Briquetting Plant

Experiments are being carried out on a wide variety of processes using peat mined by different methods. Two of them employ anaerobic digestion of wet mined peat slurries to produce methane or substitute natural gas. In each case, non-oxygen-using bacteria digest these slurries and produce the substitute natural gas.

Production of substitute natural gas using milled peat is also in the experimental stages. In one study, the process yields methane, but can be designed for synthetic gas production. In the other, both benzene and methane are produced. But neither process is expected to undercut the current price of natural gas in Ontario.

Other experiments with peat are based on the similar composition and chemical reactivity of peat and cellulosic biomass. One of these produces synthetic gas from peat by adapting coal gasification technology. Another uses an entirely new approach to accomplish the same thing. Both then convert this synthetic gas to methanol using established technology.

Commercially available technology is also being used to convert peat to form coke for metallurgical purposes, or a partially carbonized char which serves as a starting material for activated carbon. While both products are known and used in Europe, they have not been used in North America thus far.

POTENTIAL ENERGY USES

The number and scope of peat's potential energy uses will continue to grow as the technology develops. This growth will be very noticeable in Ontario since fuel peat is neither mined nor used here now.

Peat Product Tree
This Peat tree illustrates many of the agricultural, chemical and manufacturing products in which Peat already plays a part

The Monenco consultants identified a number of potential uses of fuel peat which warrant the greatest attention today:

- Large and small-scale sod peat production for residential and non-residential space heating.
- Sod peat production for industrial process heat generation.
- Sod/milled peat production for use in district heating.
- Sod peat production for power generation using a small-scale peat gasifier or direct combustion.

Cost and current technology were prime criteria in determining this list. While there are many other uses for peat, the Monenco consultants did not list those which were not economically attractive when compared with other alternatives.

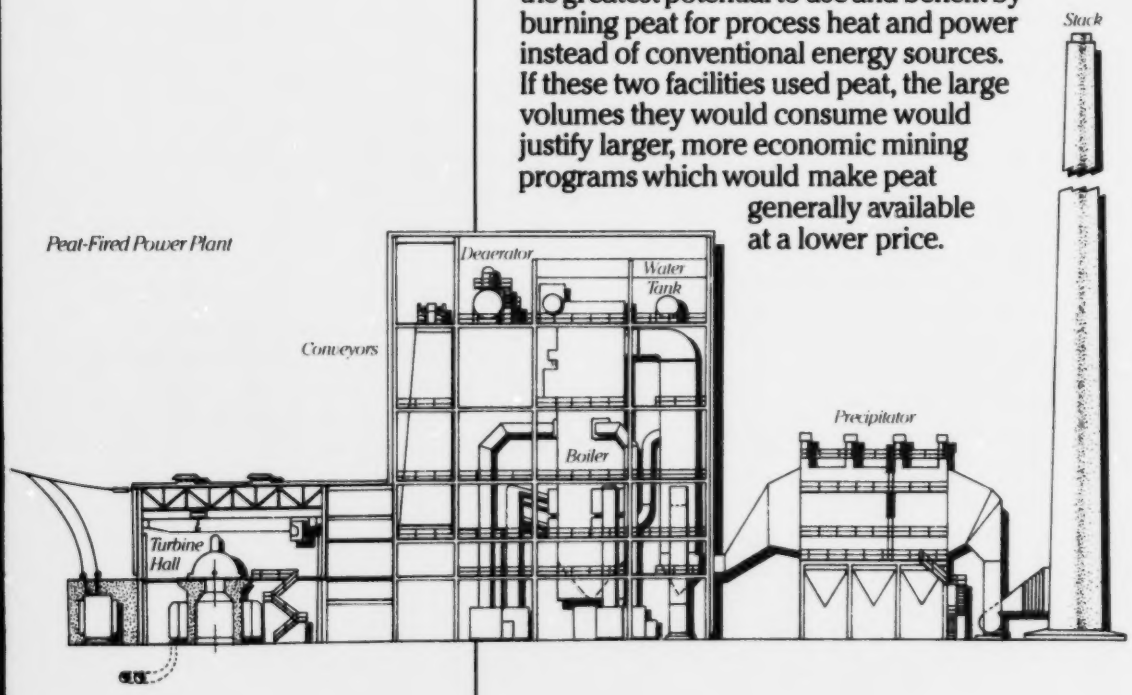
SPACE HEATING

As a fuel, either in fireplaces or furnaces made for peat or converted for its use, peat could potentially be substituted for 80 per cent of the heating load in a home or institution in some remote areas. This possibility makes the development of mining activities and consumer education appear to be very worthwhile.

The consultants recommended a demonstration project be set up to illustrate the methods of utilizing peat for small-scale space heating.

INDUSTRIAL PROCESS HEAT GENERATION

Five Ontario industries (cement manufacturing, pulp and paper mills, iron and steel mills, industrial chemicals, and smelting and refining) which use large amounts of energy were studied. Of these, a cement company near Picton and a pulp and paper plant near Kenora were found to have the greatest potential to use and benefit by burning peat for process heat and power instead of conventional energy sources. If these two facilities used peat, the large volumes they would consume would justify larger, more economic mining programs which would make peat generally available at a lower price.



DISTRICT HEATING

Many people in rural Ontario produce their own heat with wood or oil. Some even have their own electrical generators. The study found that it would be more economical to use peat-generated district heating. District heating, while common in the Scandinavian nations, is almost unheard of in Canada. It is a system which supplies heat to area homes from a central plant. The study also found that, as the cost of alternative fuels rises, peat will become even more economical. But district heating is, in general, only viable in areas having high heat-load requirements.

SMALE-SCALE POWER GENERATION

From a Peat Gasifier: Gasifier technology is still at the developmental stage. Once proven, it could be of interest to the inhabitants of remote northern communities where electricity is presently being generated by small diesel generators. These generators could be converted to cheaper peat gas firing generators; or, if the economics justify the conversion, generators built to run on peat could be used.

From Direct Combustion: Peat-powered small-scale electrical generating stations could be built at peat bogs to eliminate fuel transportation costs. The power could be used by a local industry or for area homes or businesses.

REGULATORY AND ENVIRONMENTAL GUIDELINES

To ensure that potential impacts upon the environment resulting from peat development, including impacts on land, are taken into consideration and minimized, all applications for peat exploration and/or extraction must be reviewed by the Ministry of Natural Resources (MNR).

The Ministry's Land Management Branch administers those parts of the Mining and Public Lands Acts which cover peat bog development. Applications should be submitted to the local District Office of MNR.

A list of the District Offices can be found in Appendix 1. Early contact with the appropriate District Office will help to streamline the review and approval process.

Depending on the type of activity (exploration or extraction), the degree of activity, and the area of peatland to be examined, one of the following permits or licences may be issued by the MNR District Office.

EXPLORATION PHASE

Work Permit–A short term work permit would be issued under *The Forest Fire Prevention Act* for very simple forms of exploration, such as taking one core sample from a bog for analysis.

Quarry Permit–If the applicant is investigating a bog in more detail, by taking several core samples, a Quarry Permit, limited to testing purposes only, would be issued under *The Mining Act.*

Exploratory Licence of Occupation–If an applicant proposes to investigate the peat potential of a large area, in such a manner that restoration of the area will be required, an Exploratory Licence of Occupation would be issued under *The Mining Act.*

EXTRACTION PHASE

Quarry Permit–For small-scale operations, a Quarry Permit would be issued under the *Mining Act* in cases where the applicant has a ready market for peat, knows the volume required and where it is.

Mining Lease–For major peat mining operations, the applicant would be required to submit an extraction and rehabilitation program in support of an application for a Mining Lease.

Peat development may be subject to the *Environmental Assessment Act* administered by the Ministry of the Environment in certain cases, principally where a provincial government agency is involved.

POTENTIAL INVESTMENT CAPITAL

Peat production, like other energy development projects, will doubtless become attractive to investors, both private and corporate.

The Ontario Energy Corporation (OEC) is one such investor. The OEC was established by the Ontario government to promote energy development of all types through direct investment in individual projects. But the OEC does not give grants or subsidies, nor does it usually involve itself in a project's actual operation. The OEC will consider investing in commercial peat development projects that are compatible with Ontario's energy policy and that can be expected to make a profit.

CONCLUSION

Although an Ontario peat industry is still in the initial planning stages, the Ministries of Energy, Northern Affairs and Natural Resources are involved in several projects which will speed that Industry's birth:

- The Ministry of Natural Resources is conducting a five-year peatland inventory program as part of its Energy Resource Audit. The program entails the preparation of peatlands inventory maps, and the assessment of the depth, type and quality of peat in significant deposits. The Ministry also is updating its policy on the disposition of peat resources, taking into account the current and anticipated uses of peat, competing land uses and peat mining's possible environmental impacts.
- The Ministry of Energy has provided $75,000 to the Ministry of Natural Resources for the preparation of a management plan and initial bog preparation activities for a 500 acre peat bog located near a horticultural nursery.
- The Ministry of Northern Affairs is investigating the non-energy industrial uses of peat, such as chemical feedstocks and building materials. The Ministry is also considering the use of peat for small-scale electricity generation in remote northern communities.

Major potential peat producing regions will be assessed and evaluated according to the quality and quantity of available peat and its development potential. Even though some peat bogs may be too inaccessible to make mining economically feasible, many others can and will be developed.

These provincial initiatives will provide valuable information about the potential of peat, and will hopefully stimulate interest in the development of this significant natural resource.

Ontario's vast peat resources can be one of our most important energy sources. Their development will not only reduce our dependence upon foreign energy supplies and suppliers, but will also help Ontario and Canada reach the common goal of energy self-sufficiency.

APPENDIX 1

NATURAL RESOURCES DISTRICT OFFICES

Algonquin Park
Box 219
Whitney, Ontario
K0J 2M0
(705) 637-2780

Atikokan
108 Saturn Avenue
Atikokan, Ontario
P0T 1C0
(807) 597-6971

Aylmer
353 Talbot Street West
Aylmer, Ontario
N5H 2S8
(519) 773-9241

Bancroft
Box 500
Bancroft, Ontario
K0L 1C0
(613) 332-3940

Blind River
Box 190
62 Queen Street
Blind River, Ontario
P0R 1B0
(705) 356-2234

Bracebridge
Box 1138
Bracebridge, Ontario
P0B 1C0
(705) 645-5244

Brockville
101 Water Street West
Brockville, Ontario
K6V 5Y8
(613) 342-8524

Cambridge
Box 2186
Cambridge, Ontario
N3C 2W1
(519) 658-9355

Chatham
Box 1168
435 Grand Avenue West
Chatham, Ontario
N7M 5L8
(519) 354-7340

Chapleau
34 Birch Street
Chapleau, Ontario
P0M 1K0
(705) 864-1710

Cochrane
Box 730
2 Third Avenue
Cochrane, Ontario
P0L 1C0
(705) 272-4365

Cornwall
Box 1759
113 Amelia Street
Cornwall, Ontario
K6H 5V7
(613) 933-1774

Dryden
Ontario Government Bldg.
Box 3000
Dryden, Ontario
P8N 3B3
(807) 223-3341

Espanola
Box 1340
148 Fleming Street
Espanola, Ontario
P0P 1C0
(705) 869-1330

Fort Frances
922 Scott Street
Fort Frances, Ontario
P9A 1J4
(807) 274-5337

Geraldton
Box 640
Geraldton, Ontario
P0T 1M0
(807) 854-1030

Gogama
Box 129
Gogama, Ontario
P0M 1W0
(705) 894-2000

Hearst
Box 670
631 Front Street
Hearst, Ontario
P0L 1N0
(705) 362-4346

Huronia
Midhurst, Ontario
L0L 1X0
(705) 728-2900

Ignace
Box 448
Ignace, Ontario
P0T 1T0
(807) 934-2233

Kapuskasing
6 Government Road
Kapuskasing, Ontario
P5N 2W4
(705) 335-6191

Kirkland Lake
Box 129
Swastika, Ontario
P0K 1T0
(705) 642-3222

Kenora
Box 5080
808 Robertson Street
Kenora, Ontario
P9N 3X9
(807) 468-9841

Lanark
Box 239
Lanark, Ontario
K0G 1K0
(613) 259-2942

Lindsay
322 Kent Street West
Lindsay, Ontario
K9V 4T7
(705) 324-6121

Maple
Maple, Ontario
L0J 1E0
(416) 832-2761

Minden
Minden, Ontario
K0M 2K0
(705) 286-1521

Moosonee
Box 190
Moosonee, Ontario
P0L 1Y0
(705) 336-2987

Napanee
1 Richmond Blvd.
Napanee, Ontario
K7R 3S3
(613) 354-2173

Niagara
Box 1070
Hwy. 20
Fonthill, Ontario
L0S 1E0
(416) 892-2656

Nipigon
Box 970
Nipigon, Ontario
P0T 2J0
(807) 887-2120

North Bay
Box 3070
North Bay, Ontario
P1B 8K7
(705) 474-5550

Ottawa
Ramsayville, Ontario
K0A 2Y0
(613) 822-2525

Owen Sound
611 Ninth Avenue East
Owen Sound, Ontario
N4K 3E4
(519) 376-3860

Parry Sound
4 Miller Street
Parry Sound, Ontario
P2A 1S8
(705) 746-2401

Pembroke
Box 220, Riverside Drive
Pembroke, Ontario
K8A 6X4
(613) 732-3661

Red Lake
Box 323, Hwy. 105
Red Lake, Ontario
P0V 2M0
(807) 727-2531

Sault Ste. Marie
Box 130, 69 Church Street
Sault Ste. Marie, Ontario
P6A 5L5
(705) 949-1231

Simcoe
645 Norfolk Street North
Simcoe, Ontario
N3Y 3R2
(519) 426-7650

Sioux Lookout
Box 309
Sioux Lookout, Ontario
P0V 2T0
(807) 737-1140

Sudbury
Box 3500 Stn. A
Sudbury, Ontario
P3A 4S2
(705) 522-7823

Temagami
Box 38
Temagami, Ontario
P0H 2H0
(705) 569-3622

Terrace Bay
Box 280
Terrace Bay, Ontario
P0T 2W0
(807) 825-3205

Thunder Bay
Box 5000
Thunder Bay 'F', Ontario
P7C 5G6
(807) 475-1501

Timmins
896 Riverside Drive
Timmins, Ontario
P4N 3W2
(705) 267-7951

Tweed
Metcalfe Street
Tweed, Ontario
K0K 3J0
(613) 478-2330

Wawa
Box 1160, Wawa, Ontario
P0S 1K0
(705) 856-2396

Wingham
R.R. #5, Wingham, Ontario
N0G 2W0
(519) 357-3131

REGIONAL OFFICES

Algonquin
Regional Office
Brendale Square
P.O. Box 9000
Huntsville, Ontario
P0A 1K0
(705) 789-9611

Central
Regional Office
10670 Yonge Street North
Richmond Hill, Ontario
L4C 3C9
(416) 884-9203

Eastern
Regional Office
Provincial Government Building
Concession Road
Kemptville, Ontario
K0G 1J0
(613) 258-3413

Northern
Regional Office
140 Fourth Avenue
P.O. Box 3000
Cochrane, Ontario
P0L 1C0
(705) 272-4287

North Central
Regional Office
Ontario Government Bldg.
435 James Street South
P.O. Box 5000
Thunder Bay 'F', Ontario
P7C 5G1
(807) 475-1261

Northeastern
Regional Office
174 Douglas Street West
Sudbury, Ontario
P3E 1G1
(705) 673-1111

Southwestern
Regional Office
1106 Dearness Drive
London, Ontario
N6E 1N9
(519) 681-5350

Northwestern
Regional Office
808 Robertson Street
Box 5160
Kenora, Ontario
P9N 3X7
(807) 468-3111

Leslie M. Frost
Natural Resources Centre
Dorset, Ontario
P0A 1E0
(705) 766-2451

Aviation and Fire
Management Centre
P.O. Box 310
55 Church Street
Sault Ste. Marie, Ontario
P6A 5L8
(705) 942-1800

Copies available, at $3.50 per copy, payable in advance, from the Ontario Government Bookstore, 880 Bay St., Toronto, for personal shopping. Out-of-town customers write to Publications Services Section, 5th Floor, 880 Bay St., Toronto, Ont. M7A 1N8. Tel. 965-6015. Toll free long distance 1-800-268-7540; in Northwestern Ontario, 0-Zenith 67200. MASTERCARD and VISA accepted.

ISBN 0-7743-7863-8
© Queen's Printer for Ontario
Printed December, 1982